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Engler, Philipp

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Welfare Effects of TTIP in a DSGE Model

Philipp Engler and Juha Tervala

Abstract

We analyze the welfare effects of the Transatlantic Trade and Investment Partnership (TTIP) between the United States (US) and the European Union (EU). Earlier TTIP studies analyze welfare effects in a framework where output and welfare coincide. We believe that the utility function of households, which depends on consumption and employment, is the best criterion for assessing TTIP. We measure the welfare effect of TTIP as the percentage of consumption that households would be willing to pay for TTIP in order to remain as well off with it as without it. The welfare effects of TTIP, which eliminates tariffs and cuts non-tariff measures, are always positive for the US and the EU. The reason is that the welfare gain of higher consumption more than offsets the welfare loss of a change in employment. The policy implication is that the US and the EU should continue the negotiations for the TTIP agreement.

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Contact details:

Philipp Engler (corresponding author): DIW Berlin, Mohrenstr. 58, 10629 Berlin, Germany, phone: +493089789486, email: pengler@diw.de

Juha Tervala: University of Helsinki, Department of Political and Economic Studies, P.O. Box 17, FI-00014 University of Helsinki, Finland, phone: +358503182244, email: juha.tervala@helsinki.fi

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1 Introduction

The Transatlantic Trade and Investment Partnership (TTIP) is a comprehensive agreement being negotiated between the European Union (EU) and the United States (US). According to the European Commission (2017), the aim of TTIP is “to help people and businesses by: opening up the US to EU firms, helping cut red tape that firms face when exporting, and setting new rules to make it easier and fairer to export, import and invest overseas.” It also notes that TTIP could help the EU affect global trade rules. The Office of the United State Trade Representative (2017) says that TTIP is an opportunity for American people and businesses to get better access to EU markets, which would support the US economy. Both the European Commission (2017) and the Office of the United State Trade Representative (2017) argue that imported products meet high standards that protect not just people's health and safety, but also the environment.

The pros and cons of TTIP are debated. Felbermayr et al. (2015a), for instance, agree that advantages have both economic and geostrategic components: the elimination of tariffs and non-tariff measures (NTMs) between the US and the EU should increase trade and output, while regulatory cooperation should help to impose Western standards on the world trade system. Felbermayr et al. (2015a) emphasize that critics claim that the possible benefits are modest and fear that TTIP may trigger a race to the bottom in health, safety, labor, and environmental standards.

Trade economists typically use static models to evaluate the consequences of trade agreements (see e.g. Costinot and Rodriguez-Clare 2014). The focus is on a detailed sectoral structure in a large set of countries. The trade literature analyzes long-term effects, arguing that trade liberalization affects the structure of the economy in the long term. It typically does not study adjustment dynamics of endogenous variables and ignores the fact that trade agreements are typically phased in over a number of years. Existing TTIP studies belong to this tradition.

The main contributions of our paper are to analyze adjustment dynamics and the welfare effects of TTIP in a New Keynesian dynamic stochastic general equilibrium (DSGE) model. Our DSGE model, based on Ganelli and Tervala (2015), is different from those used in the existing TTIP literature by allowing us to analyze transition dynamics of TTIP.¹ Petri and Plummer (2016) emphasize—in the context of the Trans-Pacific Partnership—that trade policy is gradual. Ghironi (2016) argues—in the context of the Trans-Pacific Partnership—that it is

¹ Capaldo (2014) uses an old Keynesian model to analyze TTIP. However, Bauer and Erixon (2015) highlight that the model Capaldo (2014) uses is not designed to analyze the effects of trade agreements. Most notably, Bauer and Erixon (2015, 2) note that it is “a demand-driven model that does not make efforts to capture the supply-side effects of trade which are the effects that are proven to be the core positive effects of trade liberalization.”

important to account for the adjustment dynamics of major trade deals, which extend far beyond reductions in tariffs. In contrast, all other main TTIP studies use static trade models and, therefore, are unable to analyze adjustment dynamics to gradual trade liberalization. The earlier TTIP literature evaluates the long-term *trade* and *output* effects of TTIP (Aichele et al. 2014, Berden et al. 2009, Felbermayr et al. 2015b, Fontagné et al. 2013, and Francois et al. 2013). Aichele et al. (2014) and Felbermayr et al. (2015b) argue that they analyze the welfare effects of TTIP, but these welfare results come from a modeling setup where real income and welfare coincide. Therefore, their welfare measure is, in effect, the change in real income that is equal to output. Raza et al. (2014) criticize TTIP studies since they neglect or downplay adjustment costs, such as changes in employment. We believe that the utility function of households, not just consumption, is the relevant welfare measure and provides the best objective in terms of which the pros and cons of TTIP should be assessed. In our model, the welfare effect of TTIP depends not only on current and future changes in consumption but also on current and future changes in employment and the initial level of employment. We measure the welfare benefit of TTIP in consumption equivalent terms: as the percentage of initial consumption that households would be willing to pay for TTIP in order to remain as well off with the TTIP case as without it.

Felbermayr (2015) argues that an important feature of the quantitative modeling of TTIP is the scenario definition, because regulatory coherence is the key of TTIP and researchers can only guess the exact nature of the partnership before its conclusion. Following the work of Francois et al. (2013) and Fontagné et al. (2013), our baseline scenario is that TTIP leads to the elimination of tariffs and a cut in NTMs of 25%.

Our simulations show that the welfare effects of TTIP are always positive for the US and the EU. The reason for the positive welfare effect is that the welfare gain caused by higher consumption more than offsets the welfare loss caused by an increase in employment. The policy implication of our results is that the US and the EU should continue the negotiations for the TTIP agreement. The discounted present value of the welfare gain of TTIP is in the range of 1.5% to 3.8% of initial consumption. This means that TTIP yields the welfare improvement that corresponds to a one-off 1.5-3.8% increase in consumption. In dollar terms, the welfare gain for a US (EU) citizen corresponds to a one-off 780-2,000 (510-1,300) US dollars increase in consumption. These welfare results are all new since the existing literature contains no analyses of the welfare effects of TTIP.

Berden et al. (2009), Francois et al. (2013), and Fontagné et al. (2013), who analyze the identical scenario, find that TTIP increases output in the US and the EU on average by 0.2-0.4% in the long term. In our model, the long-term output effect is in the range of 0.2% to 0.4%, depending on the parameterization. So our results are fully consistent with earlier TTIP studies.

Following earlier TTIP studies, we also look at the effects of a TTIP agreement that is limited to liberalizing tariffs only. A tariffs-only agreement induces a considerably smaller output effect, which is in line with the other TTIP papers. Our main focus is, however, on welfare. The welfare gain of a tariffs-only agreement is roughly one-third of the welfare gain of the baseline scenario. Therefore, we can conclude that the bulk of the welfare gain of TTIP is induced by cuts in NTMs. This result is new since the existing TTIP studies contains no analyses of the welfare effects of TTIP.

The rest of the paper is organized as follows. Section 2 introduces the model. Section 3 presents the parameterization of it. Section 4 analyzes the effects of TTIP, focusing mostly on the welfare effects. It also examines the sensitivity of the main results to variations in key parameters values. Section 5 concludes the paper.

2 Model

In this section, we introduce a New Keynesian model of trade liberalization that is based on Ganelli and Tervala (2015). We go beyond their approach in that we allow for both tariff and non-tariff barriers, because the latter constitute the major barriers to trade between the US and the EU. Furthermore, we allow trade barriers to be adjusted gradually.

The world is made up of two countries: home and foreign.² Firms and households are indexed by $z \in [0,1]$. Households and firms over the $[0,n]$ interval are located in the home country, whereas the rest $[n,1]$ are located in the foreign country. In the description of the model, if the equations are symmetric across countries, we present only domestic ones

A two-country model implies that there is no third country (or the rest of the world) so that some relevant transmission channels are absent. First, the trade diversion effect of a trade agreement, which Cheong et al. (2015) find important, is absent. This implies that the welfare effect may be overestimated in a two-country model. Second, Li et al. (2016) show that regional trade agreements benefit member countries, in terms of output and trade, while non-member countries typically lose. In the context of TTIP, Felbermayr et al. (2015b) find that the effects on non-TTIP countries' output is on average negative due to the negative trade diversion effect. On the other hand, Francois et al. (2013) find that the effects of TTIP on the rest of the world is positive because the positive trade creation effect outweighs the negative trade diversion effect.

² The use of a two-country model implies that we ignore the effects on third countries. Li et al. (2016) show that regional trade agreements benefit member countries, in terms of output and trade, while non-member countries typically lose.

2.1 Households

The domestic household's lifetime utility is given by

$$U_t = \sum_{s=t}^{\infty} b^{s-t} \log C_s + \frac{c}{1-e} \frac{M_s}{P_s(t)^{\frac{1}{e}}} - \frac{l_s(z)^{1+1/n}}{1+1/n} \quad (1)$$

In this equation $0 < b < 1$ is the discount factor, C_t is a consumption index to be defined below, c is a positive parameter, M_t is nominal money balances, $e > 0$ is the inverse of the consumption elasticity of money demand, $P_s(t)$ is the consumption price index, $l_t(z)$ is the household's labor supply, and n is the Frisch elasticity of labor supply. The expression $P(t)$ denotes the fact that the price index is a function of the trade barriers, which we denote as t . They are the sum of a tariff (t_t^T) and NTMs (t_t^{NTM}): $t_t = t_t^T + t_t^{NTM}$. Price indexes and the effect of trade barriers on them are shown below.

The overall consumption index is given by³

$$C_t = \left(k^{\frac{1}{r}} (C_t^h)^{\frac{r-1}{r}} + (1-k)^{\frac{1}{r}} (C_t^f)^{\frac{r-1}{r}} \right)^{\frac{r}{r-1}}, \quad (2)$$

where C_t^h and C_t^f represents the consumption of domestic and foreign goods, respectively, and $\rho > 0$ is the cross-country substitutability (the elasticity of substitution between domestic and foreign goods). $k^0 na$ ($0 < k < 1$) denotes the share of domestic goods in the consumption basket, which depends on the relative size of the home country (n) and the degree of home bias in consumption ($\alpha > 1$). C_t^h and C_t^f are aggregates of domestic and foreign goods,

$$C_t^h = \left(\int_0^1 C_t^h(z)^{\frac{q-1}{q}} dz \right)^{\frac{q}{q-1}} \quad (3)$$

³ The foreign consumption index is $C_t^* = \left(k^{*\frac{1}{r}} (C_t^{*h})^{\frac{r-1}{r}} + (1-k^*)^{\frac{1}{r}} (C_t^{*f})^{\frac{r-1}{r}} \right)^{\frac{r}{r-1}}$, where asterisks indicate

consumption by the foreign household. $k^{*0} na^*$ ($0 < k^* < 1$) denotes the share of domestic goods in the foreign consumption basket. Home bias requires $\alpha^* < 1$.

$$C_t^f = \frac{1}{\theta} (1 - n)^{-\frac{1}{\theta}} \int_0^1 c_t^f(z)^{\frac{\theta-1}{\theta}} dz \frac{1}{\theta}, \quad (4)$$

where $c_t^h(z)$ and $c_t^f(z)$ are the respective consumption levels of differentiated domestic and foreign good z by the domestic household, and $\theta > 1$ is the within-country substitutability (the elasticity of substitution between two goods produced in the same country).

We assume, for the sake of simplicity, that both countries impose (*ad valorem*) tariffs and NTMs on all imported goods. The optimal allocation of consumption between different types of goods is governed by the following demand functions:⁴

$$c_t^h(z) = \frac{1}{\theta} \frac{p_t^h(z)^{-\theta}}{P_t^h} \frac{1}{\theta} \frac{P_t^h}{P_t^f(t)} \frac{1}{\theta} a C_t \quad \text{and} \quad c_t^f(z) = \frac{1}{\theta} \frac{(1+t_t) p_t^f(z)^{-\theta}}{P_t^f(t)} \frac{1}{\theta} \frac{P_t^f(t)}{P_t^h} \frac{1}{\theta} \frac{1-k}{1-n} C_t.$$

The consumer price index is $P_t(t) = [k (P_t^h)^{1-\theta} + (1-k) (P_t^f(t))^{1-\theta}]^{\frac{1}{1-\theta}}$, the domestic price index

$$\text{is } P_t^h = \frac{1}{\theta} \int_0^1 p_t^h(z)^{1-\theta} dz \frac{1}{\theta}, \quad \text{and} \quad \text{the foreign goods price index is } P_t^f(t) = \frac{1}{\theta} \int_0^1 (1+t_t) p_t^f(z)^{1-\theta} dz \frac{1}{\theta}.$$

As in Fender and Yip (2000), the law of one price

holds for *producer* prices but not for consumer prices in our model. Households allocate their total consumption between domestic and foreign goods, taking into account relative prices (including trade barriers), the cross-country substitutability, and the degree of home bias in consumption. The effect of trade liberalization is clearly visible here: a reduction in trade barriers reduces the price of imported goods and thereby the consumer price index.

The budget constraint of the domestic household is given by⁵

⁴ The corresponding foreign equations are

$$c_t^{*h}(z) = \frac{1}{\theta} \frac{(1+t_t^*) p_t^{*h}(z)^{-\theta}}{P_t^{*h}} \frac{1}{\theta} \frac{P_t^{*h}}{P_t^{*f}(t)} \frac{1}{\theta} a^* C_t^* \quad \text{and} \quad c_t^{*f}(z) = \frac{1}{\theta} \frac{p_t^{*f}(z)^{-\theta}}{P_t^{*f}(t)} \frac{1}{\theta} \frac{P_t^{*f}(t)}{P_t^{*h}} \frac{1}{\theta} \frac{1-k^*}{1-n^*} C_t^*.$$

⁵ The budget constraint of the foreign household, because the bond is denominated in the domestic currency, is

$$M_t^* + D_t^*/S_t = (1+i_{t-1})(D_{t-1}^*/S_t) + M_{t-1}^* + w_t^* l_t^*(z) - P_t^*(t^*) C_t^* + p_t^* + P_t^*(t^*) T_t^*,$$

$$M_t + D_t = (1 + i_{t-1})D_{t-1} + M_{t-1} + w_t l_t(z) - P_t(t)C_t + p_t + P_t(t)T_t, \quad (5)$$

where D_{t-1} denotes an internationally traded bond purchased in period $t-1$ that pays one unit of domestic currency plus the nominal interest rate i_{t-1} in period t . The term w_t represents the nominal wage rate, p_t is nominal dividends (profits), and T_t denotes real transfers from the government.

The optimal choices with respect to the intertemporal allocation of consumption, the labor supply and money demand is given by

$$b(1 + i_t) \frac{P_t(t)C_t}{P_{t+1}(t)C_{t+1}} = 1, \quad (6)$$

$$l_t(z) = \frac{w_t}{C_t P_t(t)} \text{ and} \quad (7)$$

$$\frac{M_t}{P_t(t)} = \frac{1 + i_t}{i_t} \quad (8)$$

Equation (6) is a consumption Euler equation. Equation (7) shows that a reduction in trade barriers increases the supply of labor by decreasing the price level, thereby increasing the real wage. Equation (8) determines the demand for money.

2.2 Government and Trade Liberalization

We assume, for the sake of simplicity, that the government repays tariff and seigniorage revenues to households in a lump-sum manner. The government budget constraint, in per-capita terms, can be written as⁶

$$P_t(t)T_t = t_t^T c_t^f(z) p_t^*(z) S_t + M_t - M_{t-1}. \quad (9)$$

In equation (9), the first term on the right hand side is revenue from import tariffs. It depends on the tariff rate (t_t^T), consumption of foreign goods, and their domestic currency price.

where S_t is the nominal exchange rate, defined as the price of the foreign currency, expressed in the domestic currency. A global asset-market clearing condition requires that $nD_t + (1 - n)D_t^* = 0$.

⁶ The foreign tariff revenue (R^*) from import tariffs is $R_t^* = t_t^{T*} c_t^{h*}(z) p_t(z) (1/S_t)$.

Our way to analyze the effects of TTIP differs from the traditional approach in that we also analyze transition dynamics, rather than just the long-term effect. For that reason, the timing of the implementation of liberalization measures is crucial. Therefore, we must model trade liberalization caused by TTIP differently. Petri and Plummer (2016) emphasize—in the context of the Trans-Pacific Partnership—that trade policy is gradual. Because this seems reasonable for TTIP as well, we assume that it will have a gradual effect on transatlantic trade barriers.

We assume that the change in effective trade barriers is given by

$$\hat{t}_{t+1} = (1 - \lambda) \hat{t}_t + \hat{\varepsilon}_t, \quad (10)$$

where λ is—loosely speaking—the “depreciation rate of trade liberalization” and $\hat{\varepsilon}_t$ represents an unexpected change in trade barriers. Percentage changes from the initial steady state (denoted by the subscript zero) are denoted by hats; for example, $\hat{t}_t = dt_t/t_0$. Trade liberalization is modeled as a *permanent* negative shock to trade barriers. Equation (10) captures the idea that a trade policy change caused by the TTIP deal is gradual and after some time the steady-state level of trade barriers is lower than before.

Finally, we assume a constant supply of nominal money balances, that is, $M_t - M_{t-1} = 0$ for all t . This implies that lump-sum transfers from the government to household are equal to tariff revenues.

2.3 Firms

The domestic firm maximizes its profits

$$p_t(z) = p_t^h(z) y_t(z) - w_t l_t(z), \quad (11)$$

taking into account the production function $y_t(z) = l_t(z)$ and the demand curve for its goods. The trade barriers do not appear in equation (11), because we assume that they are borne by consumers. However, because the demand functions of consumers are affected by trade barriers, there is an indirect effect on profits. As shown in Ganelli and Tervala (2015), the profits can be written as

$$p_t(z) = [p_t^h(z) - w_t] \cdot \left[\frac{\partial p_t^h(z)}{\partial t_t} \frac{\partial t_t}{\partial \hat{t}_t} \hat{t}_t + \frac{\partial p_t^h(z)}{\partial t_t} \frac{\partial t_t}{\partial \hat{t}_t} \hat{t}_t \right] k C_t + \frac{\partial (1+t_t^*) p_t^h(z)}{\partial t_t} \frac{\partial t_t}{\partial \hat{t}_t} \hat{t}_t \frac{\partial S_t P_t^{*h}(t)}{\partial t_t} \frac{\partial t_t}{\partial \hat{t}_t} \hat{t}_t (1-n) a^* C_t \frac{\partial y_t}{\partial p_t}. \quad (12)$$

As shown in Ganelli and Tervala (2015), the optimal price under Calvo pricing (Calvo 1983) is

$$p_t^h(z) = \frac{q}{q-1} \frac{\sum_{s=t}^{\infty} \gamma^{s-t} z_{t,s} Q_s w_s}{\sum_{s=t}^{\infty} \gamma^{s-t} z_{t,s} Q_s}, \quad (13)$$

where $z_{t,s}$ is the stochastic discount factor between periods t and s , γ is the probability that a firm is able to reset its price and

$$Q_s = \frac{\partial}{\partial P_s^h} \left(\frac{1}{\beta} \sum_{t=s}^{\infty} \gamma^{t-s} \frac{\partial}{\partial P_s^h} \left(\frac{P_s^h}{P_s^*} \right) \right) K C_s + \frac{\partial}{\partial P_s^h} \left(\frac{1+t_s^*}{\beta} \sum_{t=s}^{\infty} \gamma^{t-s} \frac{\partial}{\partial P_s^h} \left(\frac{P_s^h}{P_s^*} \right) \right) (1-n) a^* C_s^*.$$

The log-linear version of equation (13) can be written as

$$\hat{p}_t^h(z) = b \hat{g}_{t+1}^h(z) + (1-b) \hat{w}_t.$$

Thus, the change in the optimal price is a weighted average of the changes in current and future nominal marginal costs, which in this model are solely determined by nominal wages.

2.4 Consolidated Budget Constraint

As shown in Ganelli and Tervala (2015), the consolidated budget constraint for the domestic economy can be written as

$$P_t C_t = D_{t-1} - d_t D_t + p_t^h(z) y_t(z), \quad (15)$$

where P_t is the domestic price index without trade barriers.

The model is log-linearized around a symmetric steady state, where initial net foreign assets are zero ($D_0 = 0$). Equation (15) therefore implies that $C_0 = y_0$. As in Ganelli and Tervala (2015), the initial level of employment and output is

$$l_0(z) = y_0(z) = \frac{\partial}{\partial q} \left(\frac{q-1}{q} \frac{p_0(z)}{P_0(t)} \right)^{\frac{1}{1+1/n}}. \quad (16)$$

This equation illustrates that the level of output depends on trade barriers and the within-country substitutability. Trade barriers increase the price level, and this in turn reduces the labor supply and output.

3 Parameterization

The parameterization of the model, summarized in Table 1, is chosen to match the features of the US and the EU. We choose 2012 as the base year in order to make the comparisons to the other TTIP studies easier. In 2012, the GDPs of the US (roughly 16,200 USD billions) and the EU were (roughly 16,600 USD billions) almost of equal size (Felbermayr 2014). We set the relative size of the home country (n) to 0.5. This simplifies the analysis.

We interpret periods as quarters. Thus the discount factor is set to 0.99. The consumption elasticity of money demand ($1/e$) is set to 1, based on Mankiw and Summers (1986). The Frisch elasticity of labor supply (n) is set to 1, based on Keane and Rogerson (2012).

Table 1. Parameterization of the Model

Parameter	Baseline value	Description
b	0.99	Discount factor
N	0.5	Relative size of the domestic economy
e	1	Inverse of the consumption elasticity of money demand
n	1	Frisch elasticity of labor supply
q	11	Within-country substitutability
r	3	Cross-country substitutability
g	0.75	Calvo parameter
t^{TB}	0.028	Initial tariff rate
t^{NTM}	0.181	Initial NTM
l	0.2	Depreciation rate of trade liberalization
\hat{e}_t	$-((1 - (0.136/0.209))^{20})$	Trade liberalization shock
A	1.895	Home bias parameter
α^*	0.105	Home bias parameter

The within-country substitutability (θ) is set to 11, which implies a 10% markup in the steady state. This is consistent with the markup estimates of Basu and Fernald (1997). They apply firm-level theory to relatively aggregated US data and within manufacturing use data on industries defined typically at the two-digit level of US Standard Industrial Classification codes. As discussed in Ganelli and Tervala (2015), in a model with endogenous labor supply, the degree of the within-country substitutability is a key parameter for the welfare analysis of trade reforms because it affects the initial output level (though not the response of the economy to shocks). If the within-country substitutability is low, then initial output is low and an increase in output and consumption (of given size) increases welfare substantially.

As highlighted by Drozd et al. (2014), the empirical literature points out that international trade reacts substantially to persistent price changes but not to temporary ones that take place on business cycle frequency. This implies that the estimates of the cross-country substitutability differ significantly, depending on the time horizon, with lower short-term estimates than long-term estimates. Consequently, they highlight that different estimates are used in international macroeconomics and trade, depending on the question at hand. In international macroeconomics, which focuses on high-frequency time-series predictions of models, it is typical to use low short-term estimates, whereas in the trade literature, which focuses on cross-sectional implications, high long-term estimates are typically used.

On the one hand, in international macroeconomics, the cross-country substitutability is often set to the range of 1 to 2. On the other hand, referring to the empirical work of Anderson and van Wincoop (2004) and Bergstrand et al. (2013), Felbermayr et al. (2015b) argue that the trade elasticity—the elasticity of substitution between goods minus one—of 7 is plausible for models that use aggregate trade flows. Our baseline choice for the cross-country substitutability is 3. This is a compromise between values used in the macro and trade literature, and is roughly consistent with the findings of Feenstra et al. (2017), who use a consumption index similar to ours. They find that the median estimates of the micro elasticity (elasticity between alternative import suppliers) are between 3.2 and 4.1, whereas the macro elasticity (elasticity between domestic and foreign suppliers) may be somewhat lower. We later assess how sensitive the welfare effects of TTIP are to changes in the cross-country substitutability in particular, since higher values may be more realistic in the long term.

Gopinath and Rigobon (2008) find that the trade-weighted median price duration of US exports and imports is roughly one year. Based on this, we set the Calvo parameter (γ) to 0.75 so that the average delay between price adjustments is one year (four periods).

Trade barriers are the sum of tariffs and NTMs. Fontagné et al. (2013) find that the *ad valorem* tariff rate on bilateral trade is on average 2.2% in the US and 3.3% in the EU. We set the tariff rate to the average of these numbers, 2.8%. We would like to emphasize that this number hides

heterogeneity in terms of tariff protections between the EU and the US that Fontagné et al. (2013) find. In most sectors, EU tariffs are low (0.2-3.7%) but somewhat higher than US tariffs. However, the EU average tariffs on motor vehicles (8.0%) and processed foods (14.6%) are much higher than the US tariffs (1.2% and 3.3%, respectively).

Felbermayr (2015) argues that a key feature of the quantitative modeling of TTIP is the measurement of NTMs. The TTIP literature uses the NTM estimates of Berden et al. (2009), who calculate an NTM index based on regulatory divergences and any type of non-tariff measure. They find that NTMs increase the cost of doing business and restrict market access for firms. They estimate sector-specific additional costs to trade across the Atlantic stemming from NTMs. They find (their Table 4.2) that the sector-specific additional costs due to NTMs vary between 2% and 73% in trade cost equivalents, meaning that NTMs correspond to a 2 to 73 percent tariff rate. However, the sector-specific additional costs are typically between a few percent to about 30%. The lowest costs to trade are in personal, cultural and recreational services; construction; and electronics. By far the highest are in food and beverages.⁷ The costs of NTMs for US exports to the EU and for EU exports to the US are on average 18.5% and 17.7%, respectively, in *ad valorem* equivalent terms. We set NTMs to 18.1%, which is the average of these numbers. So the initial overall trade barrier, the sum of tariffs and NTMs, is 20.9%.⁸

Our scenario is that TTIP eliminates tariffs entirely and reduces NTMs, while we ignore several key elements of TTIP. Berden et al. (2009) introduce the concept of actionability, the degree to which NTMs can realistically be reduced over a period of 10 years. They find that up to roughly 50% of all NTMs are actionable. Therefore, they analyze the consequences of 25% and 50% reductions in NTMs. Raza et al. (2014, VII) argue the degree of actionable NTMs of Berden et al (2009) is “too high to be realistically achievable.” Francois et al. (2013) and Fontagné et al. (2013) analyze trade liberalization that leads to a cut in the tariff rate of 98–100% and a cut in NTMs of 25%. We assume that TTIP leads to the elimination of tariffs and a cut in NTMs of 25%. This means that the trade barrier is reduced from 20.9% to 13.6%.

As mentioned earlier, a key difference of our model relative to the earlier TTIP literature is that we also analyze the short- and medium-term adjustment of the economy. In the basic case, we assume that the “depreciation rate of trade liberalization” (λ) is 0.2 and the size of the

⁷ Disdier et al. (2016) provide an assessment of the impacts of TTIP on the agri-food sector.

⁸ As pointed out by a referee, the paper incorporates NTMs into trade barriers as an additive form by quantifying them to equivalent tariff rates. This implies that the welfare effect of a reduction of NTMs is not different from that from tariff changes. Tariff changes, however, may affect the volume of international trade or output through changes in the goods' prices, while NTMs may affect the volume of international trade or output not through the price but in a different way. Therefore, future TTIP studies should explore various forms of NTM measures.

permanent trade liberalization shock (\hat{e}_t) is $-((1 - (0.136/0.209))' 100' /)$. Together, these parameters imply that trade barriers are gradually reduced from 20.9% to 13.6%.

Home bias parameters (α and α^*) are set such that the import-to-GDP ratios match the US–EU trade. However, we have to simplify the analysis assuming balanced trade. Consequently, the share of imports is identical in both countries, which means that $\alpha^* = (1 - n\alpha)/n$. According to Felbermayr (2014), EU exports to the US were roughly 550 USD billion, while US exports to EU were roughly 455 USD billion in 2012. Therefore, the EU import-to-US GDP ratio was somewhat above 3%, while the US import-to-EU GDP ratio somewhat below 3%. We set α to 1.895 and α^* to 0.105, implying that the initial import-to-GDP ratio is 3% in both countries.⁹

4 Welfare Effects of TTIP

In this section, we analyze the welfare consequences of TTIP. Lucas (1987) analyzes the welfare effects of business cycles, expressed in consumption units. Following the idea of Lucas and a more recent method of Schmitt-Grohe and Uribe (2007), which is commonly used in the DSGE literature, we measure the welfare benefit of trade liberalization as the percentage of consumption that households would be willing to pay for liberalization in order to remain as well off with the liberalization case as without it. As shown in Ganelli and Tervala (2015), the percentage of initial consumption that the household is willing to pay for trade liberalization (w_t), referred to as the value of trade liberalization in the figure, *in period t* is

$$w_t = 100' [\exp(1 - b)(\hat{C}_t - l_0^{1+1/n} \hat{l}_t) - 1]. \quad (17)$$

The discounted present value (DPV) of the welfare effect, measured by a percentage of initial consumption, is

$$w_{DPV} = 100' [\exp(1 - b) \sum_{s=t}^{\infty} b^{s-t} (\hat{C}_s - l_0^{1+1/n} \hat{l}_s) - 1]. \quad (18)$$

Equation (18) illustrates that the welfare effect of TTIP depends on current and future changes in consumption, current and future changes in labor supply and the initial level of labor supply. The welfare effect depends negatively on changes in labor supply due to the disutility of labor supply. It is, however, worth observing that the initial level of labor supply, determined by equation (16), is smaller than one. Therefore, and identical increases in consumption and labor supply always increase welfare.

⁹ We use the method of Klein (2000) and McCallum (2001) to simulate the model.

4.1 Results for the Baseline Calibration

In this section, we analyze the consequences of TTIP. Figure 1 shows the effects of TTIP, which is signed in period 1 on the main variables. The horizontal axes indicate time in all figures. Figure 1(a) shows the level of trade barriers. The vertical axes in panels (b) and (c) show percentage deviations of output and international trade from the initial steady state (SS). Panel (d) shows the value of trade liberalization in each period, determined by equation (17), which is measured by a percentage of initial consumption.

Figure 1. Dynamic Effects of TTIP

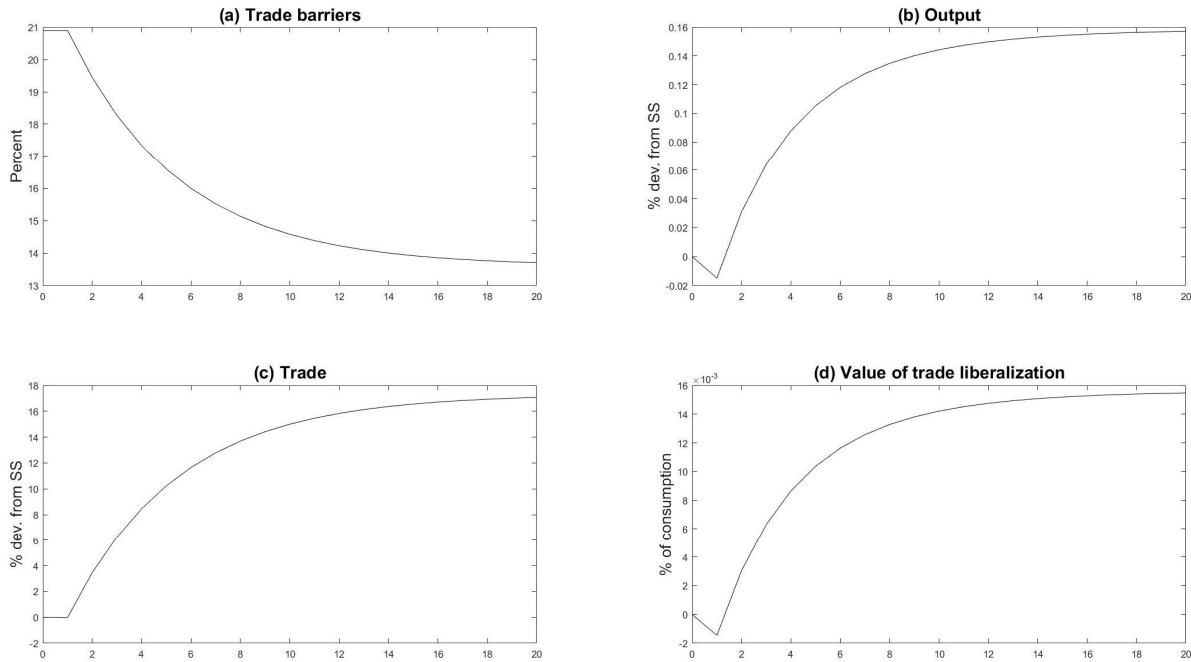


Figure 1(a) shows that trade barriers are gradually reduced. Our way of modelling of trade barriers implies that they begin to decrease one quarter after the TTIP deal is signed. Trade liberalization reduces distortions on the labor supply (recall equation (7)) because it increases real wages by decreasing the consumer price level. Figure 1(b) illustrates that TTIP increases output gradually, which is due to the gradual reduction in trade barriers that exert a gradual deflationary pressure. One year after the TTIP deal is signed, output has increased 0.08%, while the long-term effect is 0.16%.¹⁰ Countries and shocks are identical, and consequently

¹⁰ One can see that in the quarter when TTIP is signed, output drops slightly. This is caused by the expectation of reduced trade barriers in the next period while the present has not yet changed much: households expect prices to fall from then on and the incentives to work and consume more to increase. But in the initial period, neither the marginal utility of holding real money balances (due to the constant nominal money supply) nor the incentive to work more hours are much affected, while the real interest rate rises due to the expected deflation. This latter effect results in a fall in current consumption (see equation (6)).

TTIP increases output in both countries by the same amount. In addition, changes in outputs are identical to changes in consumption. Figure 1(b) therefore shows the percentage deviation of consumption from the initial steady state too. Moreover, the linear production function implies that output is equal to employment. So Figure 1(b) also shows the response of employment. The positive output effect of trade liberalization is consistent with the empirical evidence of Dollar and Kraay (2004). In a survey, Cirera et al. (2013) find that liberal trade policy is associated with higher employment. Berden et al. (2009) is the only paper in previous literature that analyzes the short-term output effects (“an immediate impact”) of TTIP. They find that output increases in the short term by 0.05% in the US and 0.11% in the EU. In our paper, the output effect one year after the shock is in line with these results.

Table 2 provides an overview of the related TTIP literature and summarizes the main findings of our paper and other TTIP studies.¹¹ Table 2 shows that our finding regarding the size of the long-term output effect is smaller than in Berden et al. (2009), Fontagné et al. (2013), and Francois et al. (2013). A common factor of all these studies is a rather small increase in GDP. Aichele et al. (2014) and Felbermayr et al. (2015b) find a much larger output effect. The key difference is that their scenario is different: a NTM reduction in the reference scenario corresponds to the estimated trade creation effects of previous regional trade agreements (RTA). Therefore, the size of trade liberalization is much larger, which explains the remarkable difference in output and trade effects.

Figure 1(c) illustrates that international trade increases gradually following gradual liberalization. The trade effect in our model is much larger than in Berden et al. (2009) and Fontagné et al. (2013), but smaller than in Francois et al. (2013). The trade effect in Aichele et al. (2014) is completely different. This is due to the different scenario. Consequently, a comparison of our results with theirs is difficult.

Figure 1(d) plots the welfare effect, measured by the percentage of initial consumption that the household is willing to pay for TTIP in each period, as shown by equation (17). It shows that households are willing to pay 0.004% of their initial consumption to avoid TTIP in the *first period*, which means that the welfare effect is negative. However, the welfare effect quickly turns positive. In an imperfectly competitive economy, an increase in output and consumption that brings them closer to their efficient levels increases welfare. In the new steady state, TTIP yields a welfare gain that corresponds to a 0.0016% increase in private consumption. Based on the World Bank (2016) data on 2012 (the base year) GDP per capita in 2014 US dollars, the *annual* welfare benefit of TTIP on a US (EU) citizen corresponds to an 8 (5) dollar increase in consumption in the steady state.

¹¹ Several papers address the effects of TTIP. We compare our results with studies that we regard as most closely related.

Table 2. Basic Assumptions and Main Results

	This study	Berden et al. (2009)	Fontagné et al. (2013)	Francois et al. (2013)	Felbermayr et al. (2015b)	Aichele et al. (2014)
Basic assumptions						
Model type	DSGE	CGE (GTAP7)	CGE (GTAP)	CGE (GTAP8)	Gravity model	Gravity model
Name of reference scenario	Baseline scenario	Limited scenario	Reference scenario	Ambitious experiment	Benchmark	Deep TTIP
Tariff reduction	100%	Goods: 100%; services 75%	100%	100%	100%	100%
NTM reduction in reference scenario	25%	25%	25%	25%	Trade creation by RTA	Trade creation by RTA
Forecasting period	Dynamic model; 2012 base year	10 years; 2008– 2018	10 years; 2015– 2025	10 years; 2017–2027	Unclear; 2012 base year	Unclear; 2007 base year
Main findings						
EU GDP	0.16%	0.32%	0.3%	0.48%	3.9% (EU average)	2.12%
US GDP	0.16%	0.13%	0.3%	0.39%	4.9%	2.68%
Change in EU exports to US	17%	0.9%	7.6%	28.0%		212%
Change in US exports to EU	17%	2.7%	10.1%	36.6%		171%
Welfare	1.5% of consumption					

Table 2 shows that the DPV of the welfare gain of TTIP is 1.5% of initial consumption. We would like to emphasize that this is defined as the one period consumption equivalent change in the DPV of flow utility for TTIP. Under the baseline parameterization, households are willing to pay 1.5% of their initial consumption for TTIP in order to remain as well off with

the TTIP case as without it. The DPV of the welfare gain of TTIP on a US (EU) citizen, based on the World Bank (2016) data on 2012 GDP per capita in 2014 US dollars, corresponds to a one-off (roughly) 780 (510) US dollars increase in consumption. These results are new, since the existing literature has not assessed the welfare effects of TTIP.

4.2 Robustness Checks: Varying Parameters

In this section, we check how sensitive the main results are to changes in key parameter values. We first analyze the role of the Frisch elasticity of labor supply and the within-country substitutability, and then we shed light on the cross-country substitutability. Table 3 demonstrates the dependence of the welfare effects of TTIP on the within-country substitutability and the Frisch elasticity. The within-country substitutability is usually set in the range of 6 to 20 in macro models, implying a massive range of markups between 5% and 20%, also implying a range of possible initial output and consumption levels. We therefore employ these two boundary values in order to shed light on the upper and lower bounds of the welfare effects of TTIP.

Keane and Rogerson (2012) find that the Frisch elasticity can be as high as 2, whereas Chetty et al. (2013) argue that it should be set to 0.5 on the intensive margin. Therefore, we vary it between 0.5 and 2. The main innovation of Ganelli and Tervala (2015), relative to the existing models in the literature on trade agreements, is to show that the welfare effects of trade liberalization are sensitive to the Frisch elasticity, because an endogenous labor supply changes the underlying steady state.

**Table 3. The Welfare Effects of TTIP:
The Role of Different Within-Country Substitutabilities and Frisch Elasticities**

	$q = 6$	$q = 11$ (benchmark)	$q = 20$
$n = 0.5$	1.7	1.0	0.59
$n = 1$ (benchmark)	2.7	1.5	0.90
$n = 2$	3.6	2.0	1.2

First, Table 3 reveals that an increase in the Frisch elasticity implies an increase in the welfare effect of TTIP. This is because the stronger is the labor supply response to trade liberalization, the stronger the boosts to output and consumption. Second, the lower is the within-country substitutability, the bigger the welfare effect. This is because a low elasticity implies a low initial level of employment and output, such that an increase in output and consumption will increase welfare more. Overall, Table 3 shows that the range of possible values of these two elasticities allows for welfare effects in the range of 0.59% and 3.6% of initial consumption.

Raza et al. (2014) highlight that the elasticity of substitution between goods is crucial for TTIP studies because it governs how strongly the model will react to trade liberalization. In our model, the cross-country substitutability can differ from the within-country substitutability. The latter affects only the level of initial employment and output, but not the response of the economy. Consequently, in our model, the cross-country substitutability is important.

Raza et al. (2014) calculate that the unweighted elasticity of substitution between goods used in Berden et al. (2009) is 6. Unfortunately, Fontagné et al. (2013) do not mention the elasticity of substitution that they use. The unweighted elasticity of substitution used in Francois et al. (2013, Table 5) is 6.3. Felbermayr et al. (2015b) set the trade elasticity - the elasticity of trade with respect to trade costs - to 7 in their benchmark parameterization. They also discuss that the elasticity of substitution between goods, which measures how changes in the price for foreign goods influences demand for foreign goods, and the trade elasticity are closely related, since the trade elasticity is equal to the elasticity of substitution minus 1. In our model, the cross-country substitutability measures alone how fluctuations in the price for foreign goods affect demand for foreign goods. Consequently, the cross-country substitutability plus 1 is equal to the trade elasticity. So Felbermayr et al. (2015b) set effectively the cross-country substitutability to 8. In Aichele et al. (2014), the average elasticity of substitution between goods is 5.6. In alternative parameterizations, we set the cross-country substitutability to 6, as in Berden et al. (2009) and Aichele et al. (2014), and to 8, as in Felbermayr et al. (2015b).

Table 4 shows the consequences of varying the cross-country substitutability, while we keep the import-to-GDP ratio constant at 3% by changing the home bias parameters.¹² Arkolakis et al. (2012) show the welfare effects of trade in several key trade models depend on only two key parameters: the share of imported goods and the trade elasticity. They show that in the basic Armington model, where goods are differentiated by the country of origin, welfare depends on only consumption, which, in turn, depends on real income. Changes in real income in turn depend on changes in the terms of trade. In addition, terms-of-trade changes are affected by the trade elasticity. A low trade elasticity implies a larger welfare effects of trade liberalization. In the context of TTIP, Felbermayr et al. (2015b), for instance, show that lower values of the elasticity of substitution lead to a higher *output* effect of TTIP, since domestic and foreign goods are less easily substitutable. Table 4 illustrates that we find the opposite. We need to emphasize that it shows the consequences of varying the cross-country substitutability, while we change the home bias parameters that govern the shares of imported goods. We do it because we wish to keep the initial import-to-GDP ratio constant at the empirically observed level. If we increase the cross-country substitutability and keep the home bias parameters constant, then the share of imported goods falls. In this case, we will find a result that is

¹² Please note that the import-to-GDP ratio is a positive function of both the home bias parameter and the cross-country substitutability.

consistent with trade models: a lower value of the elasticity of substitution leads to a higher welfare effect following trade liberalization. On the other hand, when we vary the home bias parameters to keep the import-to-GDP ratio at 3%, the welfare effects of TTIP depend positively on the degree of the cross-country substitutability, because households respond by supplying more labor. One of the features of the framework (Ganelli and Tervala 2015) used in this paper is to alter the underlying steady state of the trade models by the introduction of endogenous labor supply. In case of a high cross-country substitutability, TTIP further increases trade and output. In an imperfectly competitive economy with endogenous labor supply, an equal increase in employment and consumption that brings them closer to their efficient levels increases welfare.

As seen in Table 4, the DPV of welfare gain is as high as 3.8% of initial consumption, in the case where the cross-country substitutability is 8. In this case, the welfare gain on a US (EU) citizen, based on the World Bank (2016) data on 2012 GDP per capita in 2014 US dollars, corresponds to a one-off 2,000 (1,300) US dollars increase (approximately) in consumption.

As discussed in Section 3, Drozd et al. (2014) emphasize that trade reacts substantially differently to persistent price changes than temporary ones that take place on business cycle frequency and, consequently, estimates of the cross-country substitutability differ depending on the time horizon. In this paper, we inspect the consequences of a policy change that shift relative prices permanently. Therefore, for the question at hand, a high cross-country substitutability may be a better depiction of reality in the long term. If this is indeed the case, Table 4 shows that the welfare gains of TTIP are considerable.

Table 4. Sensitivity Analysis: Different Cross-Country Substitutabilities

	$r = 3$ (benchmark)	$r = 6$	$r = 8$
Output	0.16%	0.27%	0.38%
Trade	17%	33%	42%
Welfare	1.5% of consumption	2.7% of consumption	3.8% of consumption

In Section 4.1, we find that under the benchmark parameterization the output effect was smaller than in other TTIP studies (Berden et al. 2009, Fontagné et al. 2013 and Francois et al. 2013) in which the scenario is identical to ours. The fact that we used a lower value of the cross-country substitutability in our benchmark parameterization can explain a large part of the difference in the output results. Table 4 shows that if the cross-country substitutability is set to 6, the output effect of TTIP increases to 0.27%, which is almost as high as in the aforementioned studies, of which the average output increase is 0.32%.

An important distinction of our model relative to the TTIP studies is that we also analyze the adjustment dynamics of the economy, with gradual trade liberalization. If trade liberalization is instant, the welfare gain of TTIP will be slightly smaller and increase from 1.5% of consumption to 1.6%.

4.3 Robustness Checks: Tariffs Only

An important analytical issue is the quantitative relevance of the reduction in tariffs and NTMs when implemented in isolation. Felbermayr (2015) indeed summarizes that all TTIP studies conclude that the bulk of the trade and output effects stem from cuts in NTMs. Thus, the next step is to analyze the effects of a TTIP agreement that leads to the elimination of tariffs, while NTMs are kept constant. That is, the trade barrier is reduced from 20.9% to 18.1%. We show results for both our benchmark value of the cross-country substitutability (3) and a higher value that is closer to one employed by the traditional trade literature (6).

Table 5. Summary of the Effects of the Tariffs-Only Agreement

	This study ($r = 3$)	This study ($r = 6$)	Fontagné et al. (2013)	Francois et al. (2013)	Felbermayr et al. (2015b)	Aichele et al. (2015)
Tariff reduction	100%	100%	100%	98– 100%	100%	100%
EU GDP	0.06%	0.1%	0%	0.1%	0.27% (non- weighted EU27 mean)	0.01%
US GDP	0.06%	0.1%	0%	0.04%	0.75%	0%
Welfare	0.57% of consumption	1.0% of consumption				

Table 5 reveals that a smaller trade liberalization induces an output effect in the range of 0.06% to 0.1%. These findings are in line with the other TTIP papers, excluding Felbermayr et al. (2015b). In a “tariffs-only” agreement, the welfare gain becomes smaller and is only 36% the baseline scenario’s welfare gain. We can therefore conclude that the bulk of the welfare gain of TTIP is caused by cuts in NTMs.

5 Conclusions

We contribute to the TTIP literature by employing a DSGE business cycle model that enables the welfare analysis of TTIP. We find that the welfare gain of TTIP is the range of 1.5% to 3.8% of initial consumption, depending on the parameterization. The welfare gains of TTIP

are always positive for the US and the EU with the policy implication that the US and the EU should continue the negotiations for the TTIP agreement.

At the same time, we need to mention the limitations of our approach because it ignores several channels through which trade liberalization in general and TTIP in particular may affect welfare. First, there are many additional gains from trade that are elicited in the literature and that our model is unable to capture, including the traditional gains from specialization, the gains from access to a larger market allowing the exploitation of scale economies (Krugman, 1980), the gains from the reallocation of resources toward more productive firms resulting in higher aggregate productivity (Melitz, 2003), and the gains associated from productivity gains related to importing inputs to production (see the numerous references in the survey by Hornok and Koren (2016)). All those gains reinforce our argument because they result in aggregate productivity increases.

Second, and against the backdrop of these gains from trade liberalization, its severe costs and the unequal distribution of those costs across affected societies also need to be considered. As Hornok and Koren (2016) report in a survey, there is ample evidence (and theory to explain it) that trade increases inequality and that the associated costs may be larger than previously thought. However, the academic debate on the needed redistribution from the winners of liberalization toward its losers in order to achieve Pareto gains has occupied generations of trade economists. The lack of sufficient redistribution has been, and continues to be, a serious concern and should be dealt with more seriously both in the public and in the academic debate. In particular, the costs of inequality and the costs of redistribution should be taken into account (Antrak et al. (2017) is a valuable start in that direction), while efforts into an analysis of labor market policies are needed to inform the public debate (Cosar (2013) and Davidson and Matusz (2006) are examples in this vein).

Third, we ignore perhaps the most debated aspects of TTIP, which our framework is not able to address: the standards of investment protection and the Investor State Dispute Settlement (ISDS). Gaukrodger (2017) examines the balance between the standards of investment protection and the right to regulate in investment treaties. He points out that some critics of TTIP argue that it is a transfer of regulatory power away from national public authorities to arbitrators. Some critics point to claims, which in their view, show that the right to regulate is inordinately exposed to the rulings of arbitrators in ISDS. Some critics argue the standards of investment protection are a weapon to fight regulation. Proponents of investment protection, on the other hand, see the topic differently. Some proponents argue the aim of investment protection is to protect investment from misuse of the right to regulate because it can be used at the expense of investors. Some proponents do not regard investment treaties as a risk to the right to regulate, while some argue that they achieve a proper balance between the standards

of investment protection and the right to regulate. Our framework is not able to address the topic and we therefore do not discuss it in this paper.

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